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☐ External Interfaces
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1 Introduction

The Washington Administrative Code [WAC 173-303-640(4)(e)] requires that secondary containment be designed and operated to contain one hundred percent of the capacity of the largest tank within its boundary for tank systems containing dangerous waste. This report discusses the assessment of flooding volume that is required to be contained for the Pretreatment Facility (PTF).

2 Applicable Documents

- Washington Administrative Code, WAC 173-303, Dangerous Waste Regulations.

3 Description

3.1 Flooding Volume for (-)45 Ft. Elevation

There are two vessels in the (-) 45'-0" elevation, the Ultimate Overflow Vessel (PWD-VSL-00033) and the HLW Effluent Transfer Vessel (PWD-VSL-00043), both with a Total Volume of 5,563 cubic feet each. The total volume of a tank includes the shell volume and both head volumes.

A postulated failure of a line in the Hot Cell, from a Waste Feed Receipt Vessel at the 0 ft. elevation would drain into the Ultimate Overflow Vessel (PWD-VSL-00033) and the HLW Effluent Transfer Vessel (PWD-VSL-00043). The waste would then overflow to the secondary containment at the (-) 45'-0" elevation. The total volume of one Waste Feed Receipt Vessel is 63,384 cubic feet, which is greater than the volume of the vessels at the (-) 45'-0" elevation. A volume of 63,384 cubic feet is used to determine the liner height.

The available flood volume of the pit below the Pipe Tunnels is 72,259 cubic feet. This is determined by crediting the fact that the two compartments are hydraulically connected via an opening through the separating wall at floor level, and excluding the volume of tanks and other component/structures below flood level. Based on the available flood volume and total volume of the Waste Feed Receipt Vessel, the minimum required liner height is 21.4 feet, 2.6 feet below the bottom of the lower pipe tunnel at (-)21'-0" elevation. The details of the liner height determination are provided in Appendix A.

3.2 Flooding Volume for (-) 19 Ft. Elevation

C2 Floor Drain Collection Vessel (PWD-VSL-00045) and C3 Floor Drain Collection Vessel (PWD-VSL-00046) each have a total volume of 666 cubic feet, and are located in a pit at this elevation. The available volume in the pit is approximately 18,025 cubic feet, which is determined by the physical layout dimensions of the pit, excluding the total volume of tanks and other component/structures below flood level. Assuming the Drain Collection Vessels are full at the time of a fire incident, 4,679 cubic feet of fire fighting water could overflow into the pit after overflowing from either of the C2 or C3 Drain Vessels. Conservatively using the fire fighting water volume instead of the largest tank volume, a flooding volume of 4,679 cubic feet requires a minimum liner height of 4.3 feet. The details of the liner height determination are provided in Appendix B.

3.3 Flooding Volume for 0 Ft. Elevation

The Black Cells and Hot Cell are located at this elevation as shown in Appendix C, Figure C1. The various Black Cells located around the Hot Cell consist of different process vessels. There are hydraulic connections between the Black Cells, and between selected Black Cells and the Hot Cell. The maximum flow through a single 6" hydraulic connection in any Black cell under a liquid head of 0.75 feet is 385 gpm. The Black Cell floors and portion of the walls are lined with stainless steel. The minimum liner height is 12 inches above the highest floor elevation for all the Black Cells.

Each Black Cell is provided with a level detection sump and an emptying ejector. Fluids from all Black Cell sumps are steam ejected into the Plant Wash Vessel (PWD-VSL-00044) located at 0 ft. elevation where, after neutralization, the effluent is pumped back into the process.

The Hot Cell is lined with stainless steel to a wall height of one foot above the highest floor elevation. The floor liner is sloped toward several low point sumps with level detection and steam ejectors for discharging into Plant Wash Vessel (PWD-VSL-00044). There are four access openings in the Hot Cell Floor into the (-)45'-0" level. There is a curb and gutter arrangement in the Hot Cell around the perimeter of the access openings to the (-)45' pit below with a drain that will allow liquid to flow from the high point of the floor of the Hot Cell to the Ultimate Overflow Vessel (PWD-VSL-00033). There are two drain lines in the curbs around the access openings between the Hot Cell and the Pit. These lines will allow liquid to drain from the Hot Cell floor into the Ultimate Overflow Vessel.

The maximum postulated flood is considered as the total volume of one of the Waste Feed Receipt Vessels (FRP-VSL-00002A/B/C/D), which is 63,384 cubic feet. In the event of leak or spill, it is postulated that the total volume of one of the Waste Feed Receipt Vessels is eventually released to the associated Black Cell. After the liquid fills the cell to the high point of the floor (grout height), the liquid will flow to the adjacent Black Cells and the Hot Cell. The liquid level in the Hot Cell will eventually reach the high point of the floor (grout height) and flow through the drain lines in the curbs around the access openings into the Ultimate Overflow Vessel. Once the Ultimate Overflow Vessel is full, liquid will flow into the HLW Effluent Transfer Vessel (PWD-VSL-00043) through the common overflow between vessels. With both vessels full, the liquid will then overflow into the pit itself.

For further details refer to Appendix C.

Appendix A
Volume calculation for PT EL. (-)45'

1. Purpose

Secondary containment in the Pretreatment facility is designed and operated to contain one hundred percent of the capacity of the largest tank within its boundary. This calculation accounts for the flood volume and assesses the effects on the Pretreatment Facility (PTF). The postulated flood volume is determined by using the Total Volume (capacity of the shell and both heads), or 110% of the Maximum Operating Volume (MOV), whichever is larger.

2. Criteria and Design Inputs

The capacities of the vessels were taken from the appropriate vessel size calculations. Dimension and details of the building were taken from the Pretreatment Facility General Arrangement drawings.

3. Assumptions

It is assumed that the postulated flood volume is the total volume of the largest vessel in the containment area or 110% of the Maximum Operating Volume which ever is larger. For the PT facility the Maximum Postulated Flood is the Total Volume of one of the Waste Feed Receipt Vessel (FRP-VSL-00002A/B/C/D) and equals 63,384 cubic feet. We assume that the total volume will make its way into the pit at the (-)45'-0" level. The "Black Cells" are defined as Rooms P-0102, P-0102A, P-0104, P-0106, P-0108, P-0108A, P-0108B, P-0108C, P-0109, P-0111, P-0112, P-0113, P-0114, P-0117, and P-0117A. The Hot Cell is defined as Room P-0123. The Pit is defined as the rooms at the (-)45'-0" level, P-B002 and P-B003. It is assumed that leakage or spillage from one of the lines connected to a Waste Feed Receipt Vessel eventually releases the total volume in the Hot Cell. There is a curb and gutter arrangement in the Hot Cell that will allow liquid to move from the high point of the floor of the Hot Cell to the Ultimate Overflow Vessel (PWD-VSL-00033). We assume that at the time of the postulated flood, the two vessels in the Pit, (the Ultimate Overflow Vessel (PWD-VSL-00033) and the HLW Effluent Transfer Vessel (PWD-VSL-00043)), are full. We estimate that the associated piping and supports equals 1% of the vessel Total Volume.

4. Methodology

Using the above criteria, design inputs, and assumptions, the postulated scenario is that the total volume of one of the FRP vessels is released into the Hot Cell via a pipe failure from one of the Waste Feed Receipt Vessels. The flood will make it's way to the –45' Pit below through a curb and gutter arrangement and into the Ultimate Overflow Vessel (PWD-VSL-00033) (refer to Appendix C for further details on the curb and gutter arrangement). Once the capacity of the vessel is reached, an overflow line will allow the flood to move into the HLW Effluent Transfer Vessel (PWD-VSL-00043). When the capacity of both vessels have been reached, an overflow line will allow the flood to be released into the sump in rooms P-B002 and P-B003. By knowing the volume of the flood and accounting for the volume of the vessels and estimating the volume of the associated piping and vessel supports we can determine the maximum level in the pit.

5. Calculations

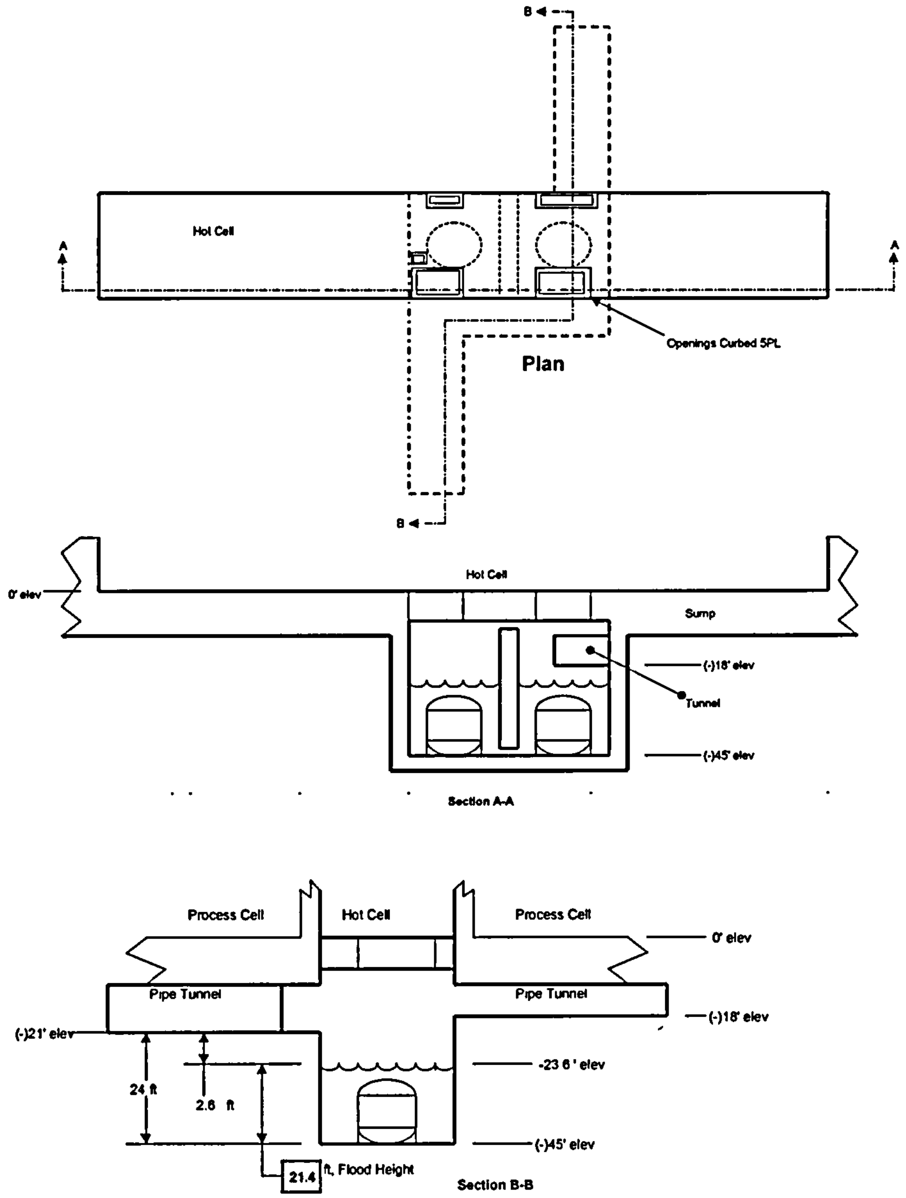
Room P-B002 is 35.5 feet by 49 feet for a total area of 1,740 square feet.
Room P-B003 is 35.5 feet by 49 feet for a total area of 1,740 square feet.
The combined area in the Pit is 3,479 square feet.
The total volume of the Ultimate Overflow Vessel is 5,563 cubic feet.
The total volume of the HLW Effluent transfer Vessel 5,563 cubic feet.
The volume of the associated piping and supports is estimated to be 111 cubic feet.
Adding together the total volume of the two vessels and the estimate for the piping and supports will yield the total excluded volume of 11,237 cubic feet.
The Maximum Postulated Flood Volume is 63,384 cubic feet.
The available volume within the pit, below the pipe tunnels is 72,259 cubic feet.

Dividing the Total Flood Volume by the combined area in the Pit will result in the height of the flood in the pit, which is 21.4 feet, which is 2.6 feet below the pipe tunnels

6. Conclusions

- The Pit can contain the volume created by the Maximum Postulated Flood.
- The flood would be 21.4 feet above the floor of the pit, corresponding to a building elevation of (-)23.6 feet .
- The flood would be 2.6 feet below the pipe tunnel

Figure A1 Calculation of Flood Volume estimate for (-)45'0" Level Pit, Pt Facility



Width of room P-B002 and P-B003 =	35 5	feet
length of room P-B002 and P-B003 =	49	feet
Height of room P-B002 and P-B003 below tunnel =	24	feet
Area of pit =	3479	square feet
Total Volume of Ultimate overflow vessel =	5,563	cubic feet
Total Volume of HLW Effluent transfer vessel =	5,563	cubic feet
Estimate of piping and support volume =	111	cubic feet
Total excluded volume =	11,237	cubic feet
Maximum Postulated Flood volume =	63,384	cubic feet
Available volume below the pipe tunnels =	72,259	cubic feet
Height in the pit =	21.4	feet
Which is	2.6	feet below the tunnel

Appendix B

Volume Calculation for PT EL. (-)19'

1. Purpose

Fire fighting sprinklers have been placed in the C2 and C3 areas of the Pretreatment Facility (PTF). In the event of a fire, large amounts of fire water must be collected and contained with in the building. The C2 and/or C3 Area Floor Drain System would bring the water into the pit at the (-)19'-0" level. This calculation is to document the height of the fire fighting water in the pit. The pit will be lined with epoxy, this calculation will set the minimum height of the coating.

2. Criteria and Design Inputs

The sprinkler density to be accommodated by the floor drains is 0.2 gpm per square foot over an operating area of 3,000 square feet. In addition a fire hose stream of 250 gallons per minute should be added to drain away requirements but this is not assumed as using the same floor drain. The sprinkler operating duration is 30 minutes and the total fire water collection storage volume is considered to be 35,000 gallons.

Two vessels are provided to collect the fire water, both are located in the pit at the (-)19'-0" level, the C2 Floor Drain Collection Vessel (PWD-VSL-00045), and the C3 Floor Drain Collection Vessel (PWD-VSL-00046). Each vessel has a total volume of 4,982 gallons. The normal operating batch volume is 1,750 gallons. This is adequate for mop water and other drainage collection (estimated at less than 50 gpm for short duration's) but is deficient volume for attending the 35,000 gallons fire fighting requirements.

During the design basis fire accident, each vessel is permitted to overflow into the equipment pit (located at the (-) 19'-0" level) which has a storage capacity far in excess of the 35,000 gallon collection requirement.

3. Assumptions

In the event of a fire, the postulated flood volume from the fire water will be 35,000 gallons. We assume that the complete volume of fire water will make it's way into the pit at the (-)19'-0" level. The Fire Pit is defined as the rooms at the (-)19'-0" level, PST10 and PST10A. We assume that at the time of the postulated flood, the two vessel in the Fire Pit, (PWD-VSL-00045 and PWD-VSL-00046), are full. We estimate that the associated piping and supports equals 5% of the vessel Total Volume.

4. Methodology

The total volume of the fire water flood is a sum of three items:

1). The volume of the fire water
2). The volume of the submerged portion of the vessels
3). A estimate of the volume of the submerged piping and supports.

The total volume is then divided by the floor area and the height is obtained.

In order to determine the volume of the submerged portion of the vessels, you need to know the height of the total flood volume. Therefore and estimate of the height is used and the solution iterated. The method used to determine the volume of the submerged portion of the vessels is the same method used to size the vessels.

The minimum height of the epoxy coating will be the height of the flood volume rounded up to the nearest quarter of a foot.

5. Calculations

The postulated flood volume from the fire water is 35,000 gallons.
The volume of the submerged portion of the vessels is 517 cubic feet.
An estimate of the submerged piping and supports is 67 cubic feet.
For a total of 584 cubic feet.
The area in the fire water pit is equal to 1,214 square feet.

The height of the flood volume is 4.3 feet.
The minimum height of the epoxy coating will be 4.5 feet.

6. Conclusions

- The height of the flood volume is 52 inches.

- The minimum height of the epoxy coating will be 54 inches.

Figure B1 Estimate of Liquid Level in Fire Water Collection Pit

Preliminary Calculation

Estimate of Liquid Level in Fire Water Collection Pit
Preliminary Calculation

Assumptions:
Design fire load = 35,000 gal
1 gal = 0.13368 ft^3
1 ft^3 = 7.481 gal
Room Dimensions 22'-0" X 49'-0",
and 17'-0" X 8'-0", see Figure (1)
All Vessels and piping full at time of fire
Volume of Fire Water:

35,000	gal =
4678.8	ft^3

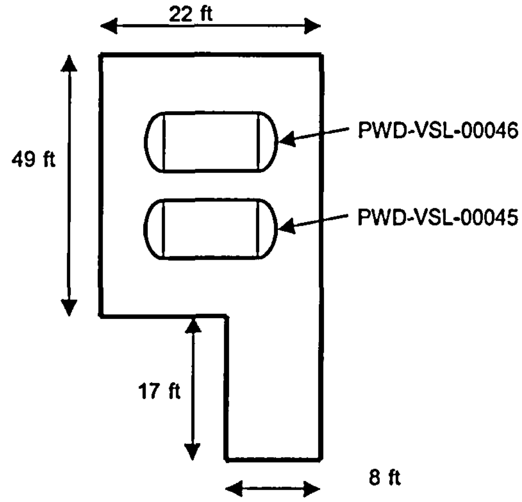


Figure (1), Fire Water Collection Pit (Plan)
NTS

Flooded Area Dimensions:

49	ft Length 1
22	ft Wide 1
8	ft Length 2
17	ft Wide 2
1,214	ft^2 (Pit Area)
16	ft Height

Vessel Data:

4,982	gal = Vessel Total Volume
96	in = Vessel Diameter
174	in = Vessel Length (Crown to Crown)
126	in = Vessel Length (Tan to Tan)
12	in = Height of Vessel Saddle

Estimate ft^3 of piping and supports under water line:

67	ft^3 (5% of Total Volume of Vessels)
498	gal

18,025	ft^3 equal the available volume in the pit

Estimates:

52.0	(in) = Estimated height of water in Pit
52.0	(in) = Calculated height of water in Pit

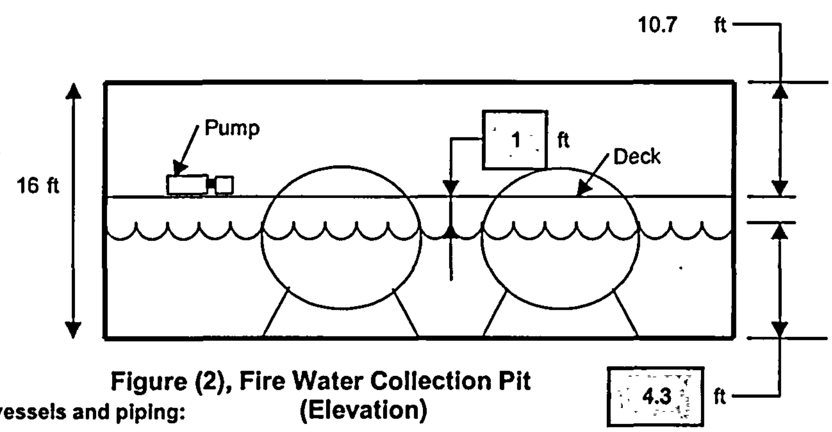


Figure (2), Fire Water Collection Pit (Elevation)
NTS

Determine Deductions for submerged saddles, vessels and piping:

40	(in) = h of vessel under water
80.43	= θ
359,929	(in^3) = Volume of Shell
43599	(in^3) = Volume of Head

894,252	(in^3) = Total Volume of Vessels Under Water (two vessels)
3,871	(gal) = Total Volume of Vessels Under Water
518	(ft^3) = Total Volume of Vessels Under Water

584	(ft^3) = Total Deductions
4,370	gal

Appendix C
Volume Calculation for PT EL. 0'

1. Purpose

The purpose of this calculation is to determine the minimum required liner height and the cladding requirements in the Hot Cell and the Black Cells of the Pretreatment Facility, (PTF), at elevation 0'-0". Secondary containment in these areas are designed with hydraulic connections between Black Cell to Black Cell and Black Cell to Hot Cell to allow any large releases of material to move through the cells and drain below into the (-)45'-0" Pit area. The Pit area can contain one hundred percent of the postulated flood (refer to Appendix A for further details). The postulated flood volume is determined by evaluating the volume of the single largest vessel in the containment area. The volume of the postulated flood is defined as the Total Volume (capacity of the shell and both heads), of the largest vessels, or a 110% of the Maximum Operating Volume (MOV) of the same vessel, whichever is larger. The flow rate of the hydraulic connections, between cells, is also estimated.

2. Conclusion

- The "Liner Height" in the Hot and Black Cells is 12 inches minimum.
- The "Grout Height" in the Hot and Black Cells is 13 inches maximum.
- The "Liner Elevation" in the Hot and Black Cells is 25 inches minimum.
- The "Drain Grout Height" at the Hot Cell Drain is 13 inches maximum.
- The Curb Height around the access openings in the Hot Cell is 12 inches.
- The flow through each hydraulic connection can be as much as 385 gpm with a flood level at the recommended minimum liner elevation

No margins have been added to these numbers. These values reflect static; equilibrium conditions and do not account for construction margins, tolerances, allowances and methods.

3. Criteria and Design Inputs

The capacities of the largest vessels within each containment area were taken from the appropriate vessel size calculations. Dimension and details of the building were taken from the Pretreatment Facility General Arrangement drawings.

Hydraulic connections would allow the flood to flow within the cells and eventually end up at the (-) 45'-0" Level. For information regarding the flood below grade levels refer to Appendix A. Estimates on flow rate for the hydraulic connections considered the flood level to be at the minimum liner elevation.

This calculation addresses the static, steady-state, equilibrium conditions, and arrives at the minimum required liner height for the following Pretreatment Facility Cells: P-0102, P-0102A, P-0104, P-0106, P-0108, P-0108A, P-0108B, P-0108C, P-0109, P-0111, P-0112, P-0113, P-0114, P-0117, P-0117A and P-0123.

4. Assumptions

It is assumed that the postulated flood volume is the Total Volume of the largest vessel in the containment area or 110% of the Maximum Operating Volume which ever is larger. For PTF the Maximum

Postulated Flood is the Total Volume of one of the Waste Feed Receipt Vessels (FRP-VSL-00002A/B/C/D) and equals 473,995 gal (63,384 cubic feet).

The "Black Cells" are defined as Rooms P-0102, P-0102A, P-0104, P-0106, P-0108, P-0108A, P-0108B, P-0108C, P-0109, P-0111, P-0112, P-0113, P-0114, P-0117, and P-0117A. The Hot Cell is defined as Room P-0123. The Pit is defined as the rooms at the (-)45'-0" level, P-B002 and P-B003. A simplified layout of the areas are shown in Figure C1. Placement of the sumps are also shown.

Figure C2, represents a simplified cell liner detail. A 1% slope is assumed for all cells liners. The "Liner Height" is defined as the cladding on the walls, as shown. The "Grout Height" is defined as the maximum depth of grout necessary to maintain a 1% slope on the floor of each cell. The "Liner Elevation" is the sum of the "Liner Height" and the "Grout Height" and represent the elevation of the liner above the 0'-0" Level.

Hydraulic connections between the Black Cells and the Hot Cell allow the flood volume to flow into the Hot Cell. There is a curb and gutter arrangement in the Hot Cell that will allow liquid to flow from the high point of the floor of the Hot Cell to the Ultimate Overflow Vessel (PWD-VSL-00033). There are four access openings in the Hot Cell floor into the (-)45'-0" level. The height of the curbs around the access openings is 25 inches above the 0'-0" elevation. A simplified detail of the Hot Cell Drain is shown in Figure C3.

The values presented in this calculation reflect static; equilibrium conditions and do not account for construction methods, margins or allowances.

In order to determine the "Liner Elevation", the "Grout Height" must be estimated. This will require assumptions to be made about the configuration used to slope the floor in each cell. Construction tolerance and practices were not considered. Figure C4; illustrates three typical liner variations. The liner type assumed in this calculation for each cell is documented in column 7 of Table C1.

Figure C5, displays the typical hydraulic connection assumed in this calculation. 6 inch schedule 40 pipe(s) are used to connect the cells and these are located at the maximum floor (grout) height. It is assumed that there will be a minimum of two connections in each wall separating the Black Cells. It is also assumed that selected Black Cells will be hydraulically connected to the Hot Cell.

The estimate of flow through the hydraulic connections assumes that the flood level is at the recommended minimum liner elevation to demonstrate the flow capability of each connection.

5. Methodology

Using the above criteria, design inputs, and assumptions, the following scenario is postulated:

The complete volume of one of the Waste Receipt Vessels is eventually released into one of the Black Cells via a leak or spill. After the liquid fills the cell up to the high point of the sloped floor, the liquid will flow to adjacent Black Cells and Hot Cell through the hydraulic connections and eventually by way of the curb and gutter system will flow into the Ultimate Overflow Vessel (PWD-VSL-00033). Flow through the hydraulic connections is estimated by summing the losses and subtracting them from the assumed differential across the opening, at an assumed velocity and assuming the liquid level is at the minimum liner elevation. The entrance and exit losses were determined using the following equations: $h = KV^2/2g$. The losses in the pipe were determined using Darcy's equation: $h = fLV^2/2Dg$. The flow was determined using: $Q = A(2gh_{total})^{1/2}$. The velocity was then verified and iterated as required.

6. Calculations

6.1 For the Black Cells and Hot Cell:

Values representing the length and width of each of the rooms, can be found in Table C1, columns 2 and 3. From these values the perimeter and floor area for each cell can be determined. (See Table C1, columns 4 and 5.) Knowing the maximum drain path in each cell, and using the assumption that the floor is sloped at 1%, we can determine the "Grout Height". (See Table C1, columns 9 and 10). The maximum "Grout Height" is estimated to be approximately 13 inches. Summing the "Grout Height" and the "Liner Height" results in a 25 inch calculated minimum liner elevation. The recommended minimum liner elevation is 25 inches. (See Table, C1 column 12.)

The estimate of the maximum drain path in the Hot Cell is 97 feet (Table C1 column 9). Knowing that the floor is sloped a 1% allows us to determine the "Drain Grout Height" at approximately 12.7 inches. The recommended maximum "Drain Grout Height" is 13 inches. (Table C1, column 10).

6.2 Flow Through the Hydraulic Connections

The flow through each hydraulic connection is determined applying the above methodology and assuming the flood level is at the recommended minimum liner elevation. Refer to Figure C6.

The length of the pipe (L) = 4 feet.
The kinematics viscosity of water at 70^0 F, (v) = 0.0000106 sqft/sec.
The Specific roughness for steel piping, (e) = 0.0002 ft
The friction factor, (f) = 0.0183
The flow coefficient (C) = 1, (accounted for in head loss).
The acceleration of gravity, (g) = 32.2 ft/sec^2.
The diameter of a 6 inch, schedule 40 pipe, (D) = 0.5054 ft
The cross-sectional area of a 6 inch schedule 40 pipe, (A) = 0.2002 ft^2
The K_{ent} factor for the entrance into the pipe was considered to be 0.5.
The K_{exit} factor for the exit from the pipe was considered to be 1.0.
The available head (h_a) across the hydraulic connection is 9 inches or 0.75 ft head from the liquid level to the centerline of a hydraulic connection.

The losses due to the pipe entrance, $h_{ent} = k_{ent}V^2/2g$ = 0.142 ft head.
The losses due to the pipe exit, $h_{exit} = k_{exit}V^2/2g$ = 283 ft head.
The Reynolds number is Re = DV/v = 203,600 therefore in the turbulent flow region.
Using Darcy's equation the losses in the pipe $h_{pipe} = fLV^2/2Dg$ = 0.041 ft head.
The total head (h_{total}) = $h_a - h_{ent} - h_{exit} - h_{pipe}$ = 0.284 ft head

The flow (Q) =$CA(2gh_{total})^{1/2}$ = 385 gpm.

The velocity was verified (V) = Q/A = 4.278 ft/sec, which is very close to the assumed value.

With 0.75 feet of head across a 6 inch schedule 40 hydraulic connection the flow rate is estimated to be 385 gpm.

Table C1 Liner Height Estimate

Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 9	Col 10	Col 11	Col 12	Col 13	Col 14	Col 15
Cell #	Length (ft)	Width (ft)	Cell Floor Area (Sqft)	Cell Perimeter (ft)	Elev. (ft)	Liner Type (See Figure 4)	Estimate Max Drain Path (ft)	Calculated Grout Height (in)	Recommended Max Grout Height (in)	Estimated Liner Height (in)	Recommended Minimum Liner Elev. (in)	Sump #	Comment
P-0102	56 8	52.0	2,955	218	0'-0"	Type B	81	9.7	10.0	12.0	25 0	PWD-SUMP-00006	Black Cell, Stainless Steel Lined
P-0102A	72.9	52.0	3,792	250	0'-0"	Type B	89	10.7	11.0	12.0	25.0	PWD-SUMP-00005	Black Cell, Stainless Steel Lined
P-0104	77.1	52.0	4,008	258	0'-0"	Type B	106	12.7	13.0	12.0	25.0	PWD-SUMP-00004	Black Cell, Stainless Steel Lined
P-0106	87.8	52.0	4,567	280	0'-0"	Type B	106	12.7	13.0	12.0	25.0	PWD-SUMP-00003	Black Cell, Stainless Steel Lined
P-0108	52.2	52.0	2,713	208	0'-0"	Type C	104	12.5	13.0	12.0	25.0	PWD-SUMP-00002A	Black Cell, Stainless Steel Lined
P-0108A	52.3	52.5	2,747	210	0'-0"	Type C	105	12.6	13.0	12.0	25.0	PWD-SUMP-00002	Black Cell, Stainless Steel Lined
P-0108B	52.3	52.5	2,747	210	0'-0"	Type C	105	12.6	13.0	12.0	25.0	PWD-SUMP-00001	Black Cell, Stainless Steel Lined
P-0108C	52.3	53.5	2,800	212	0'-0"	Type C	106	12.7	13.0	12.0	25.0	PWD-SUMP-00001A	Black Cell, Stainless Steel Lined
P-0109	28.5	54.0	1,539	165	0'-0"	Type C	83	9.9	10.0	12.0	25.0	PWD-SUMP-00007	Black Cell, Stainless Steel Lined
P-0111	48.0	34.5	1,656	165	0'-0"	Type C	83	9.9	10.0	12.0	25.0	PWD-SUMP-00008	Black Cell, Stainless Steel Lined
P-0112	50.5	34.5	1,742	170	0'-0"	Type C	85	10.2	11.0	12.0	25.0	PWD-SUMP-00009	Black Cell, Stainless Steel Lined
P-0113	29 5	34.5	1,018	128	0'-0"	Type C	64	7.7	8.0	12.0	25 0	PWD-SUMP-00010	Black Cell, Stainless Steel Lined
P-0114	49 5	34.5	1,708	168	0'-0"	Type C	84	10.1	11.0	12.0	25.0	PWD-SUMP-00011	Black Cell, Stainless Steel Lined
P-0117	57.6	34.5	1,987	184	0'-0"	Type C	92	11.0	12.0	12.0	25.0	PWD-SUMP-00012	Black Cell, Stainless Steel Lined
P-0117A	59.8	34.5	2,064	189	0'-0"	Type C	94	11.3	12.0	12.0	25.0	PWD-SUMP-00013	Black Cell, Stainless Steel Lined
P-0123	350.5	51.0	17,876	863	0'-0"	Type A	97	11.6	12.0	12.0	25.0	PWD-SUMP-00026 PWD-SUMP-00028 PWD-SUMP-00029	Hot Cell, Stainless Steel Lined

Figure C1 Simplified PT F Building Layout, Process Cells and Hot Cell

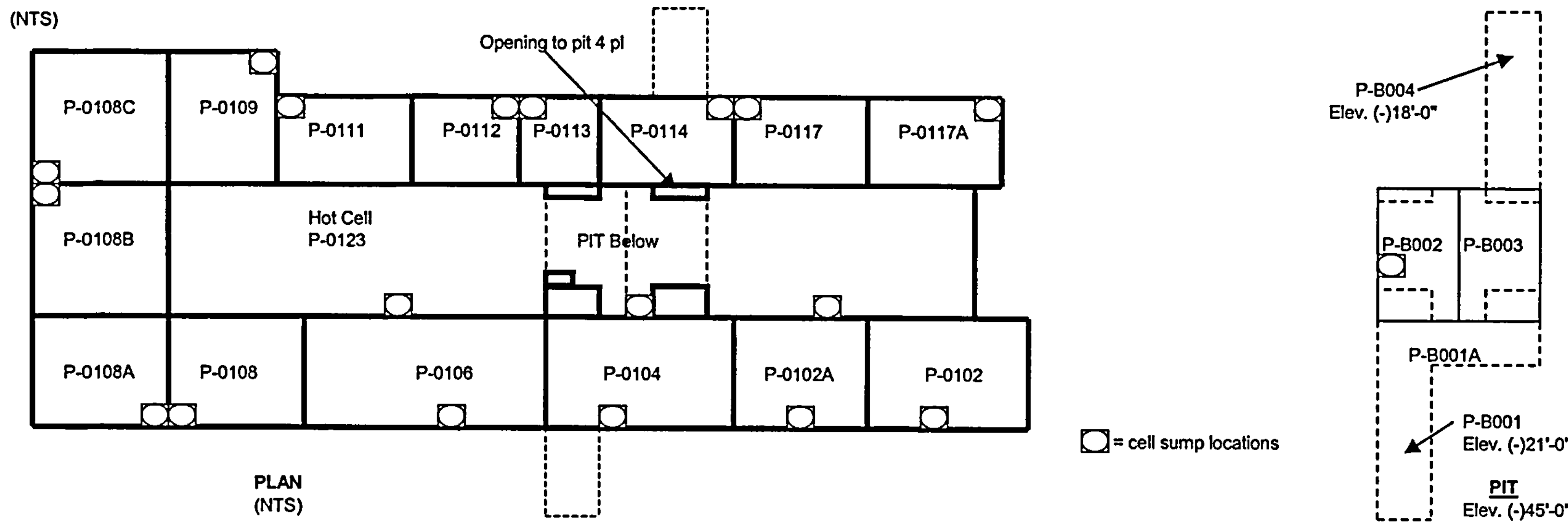


Figure C2 Simplified Cell Liner Detail

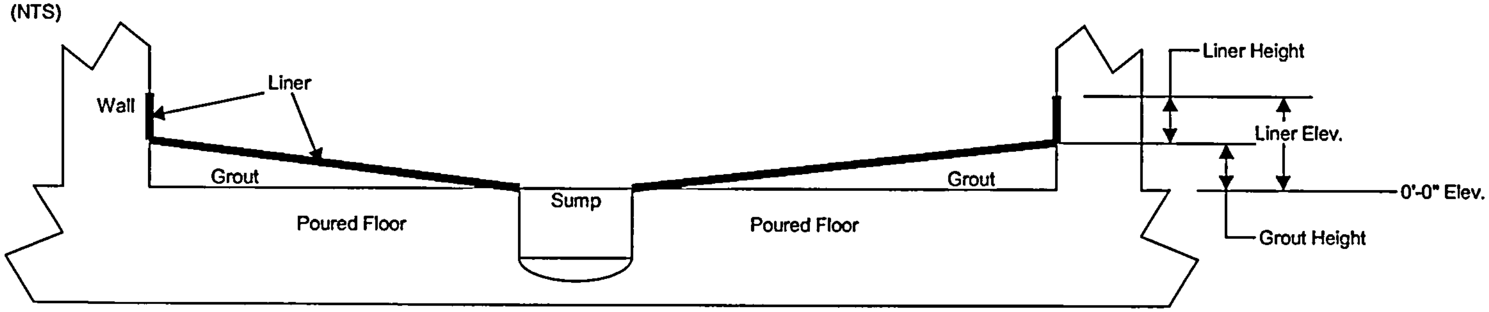


Figure C3 Hot Cell Floor Drain Detail

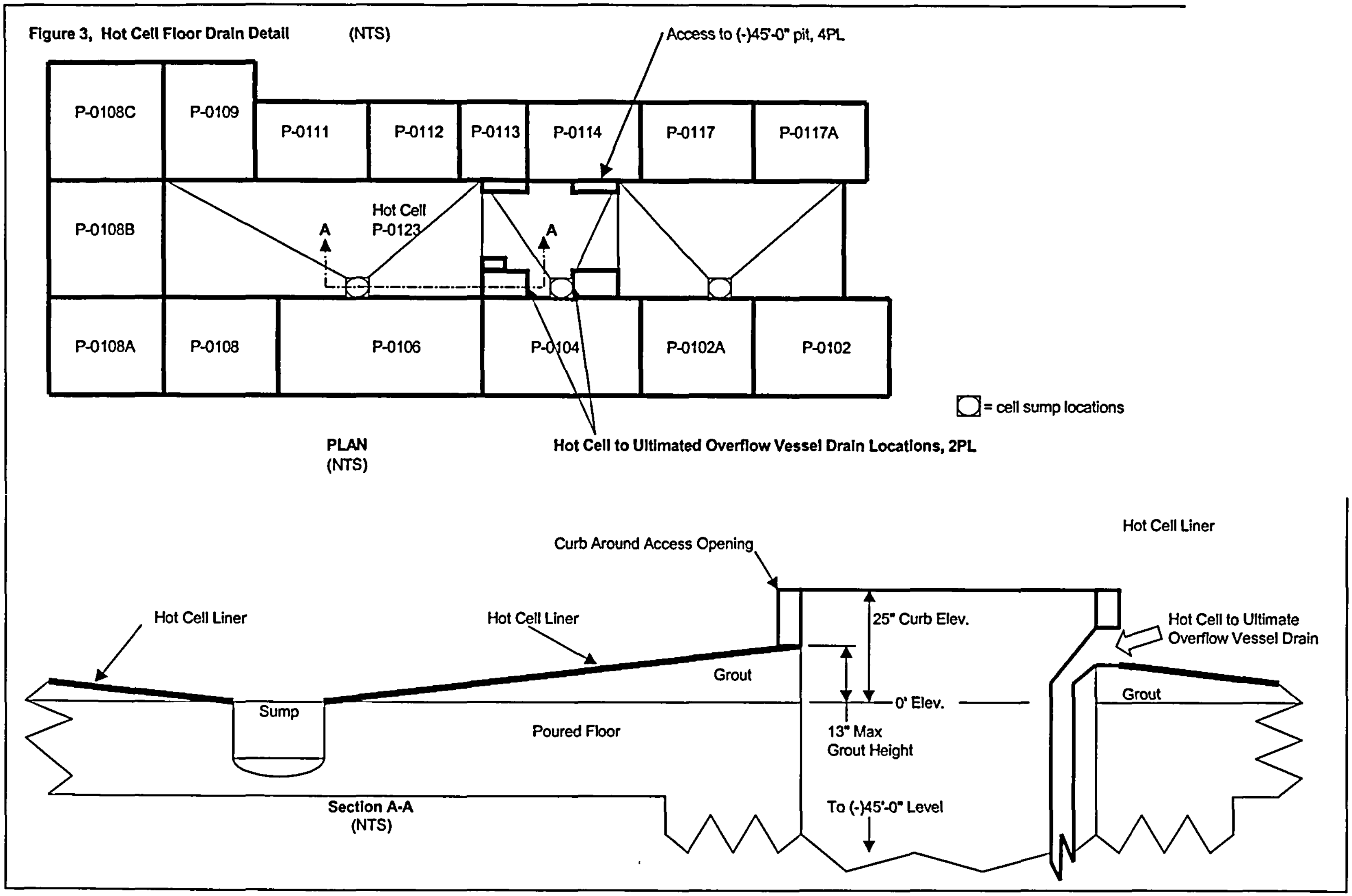


Figure C4 Typical Liner Slope Configuration

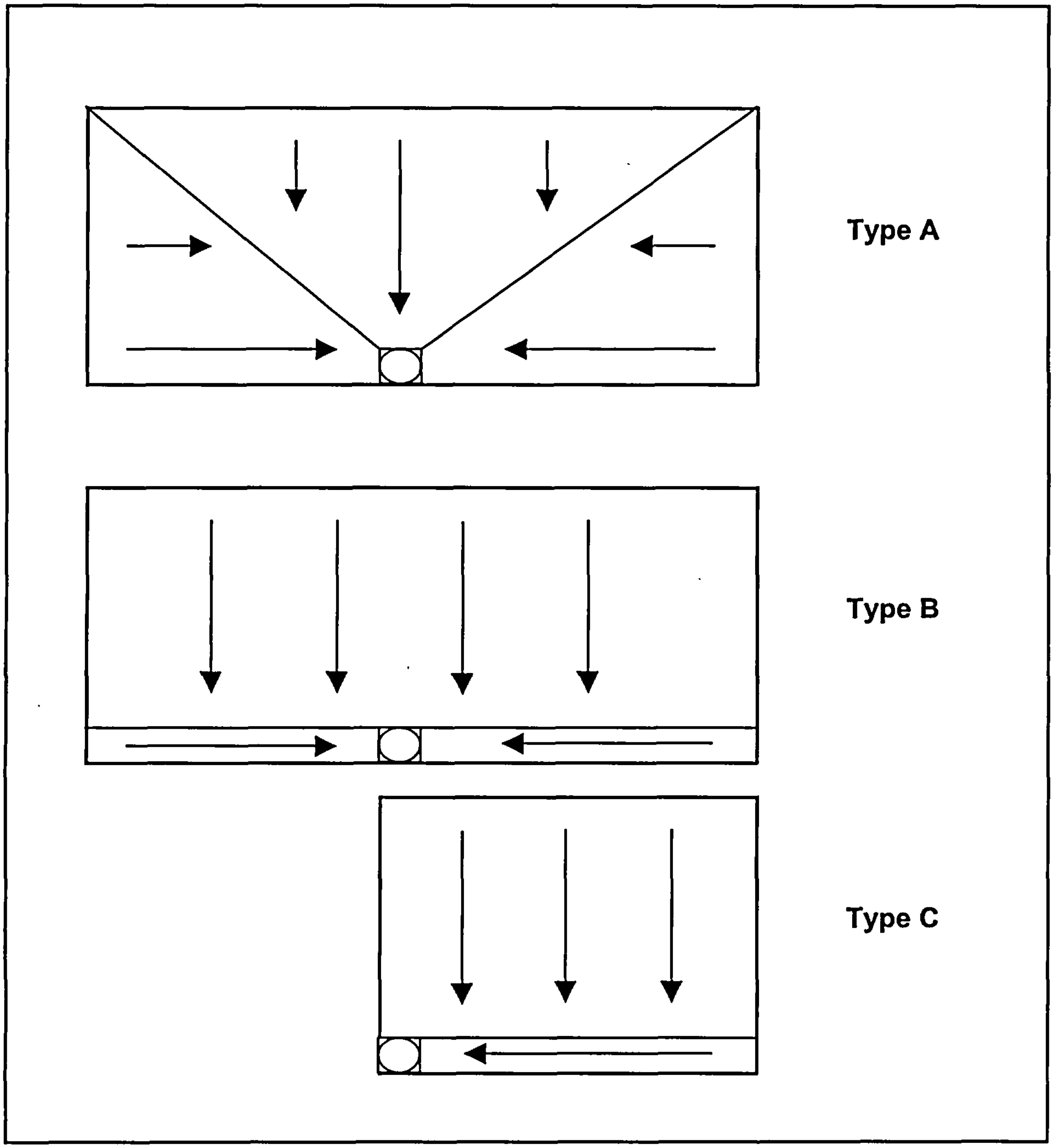


Figure C5 Typical Cell to Cell Hydraulic Connection

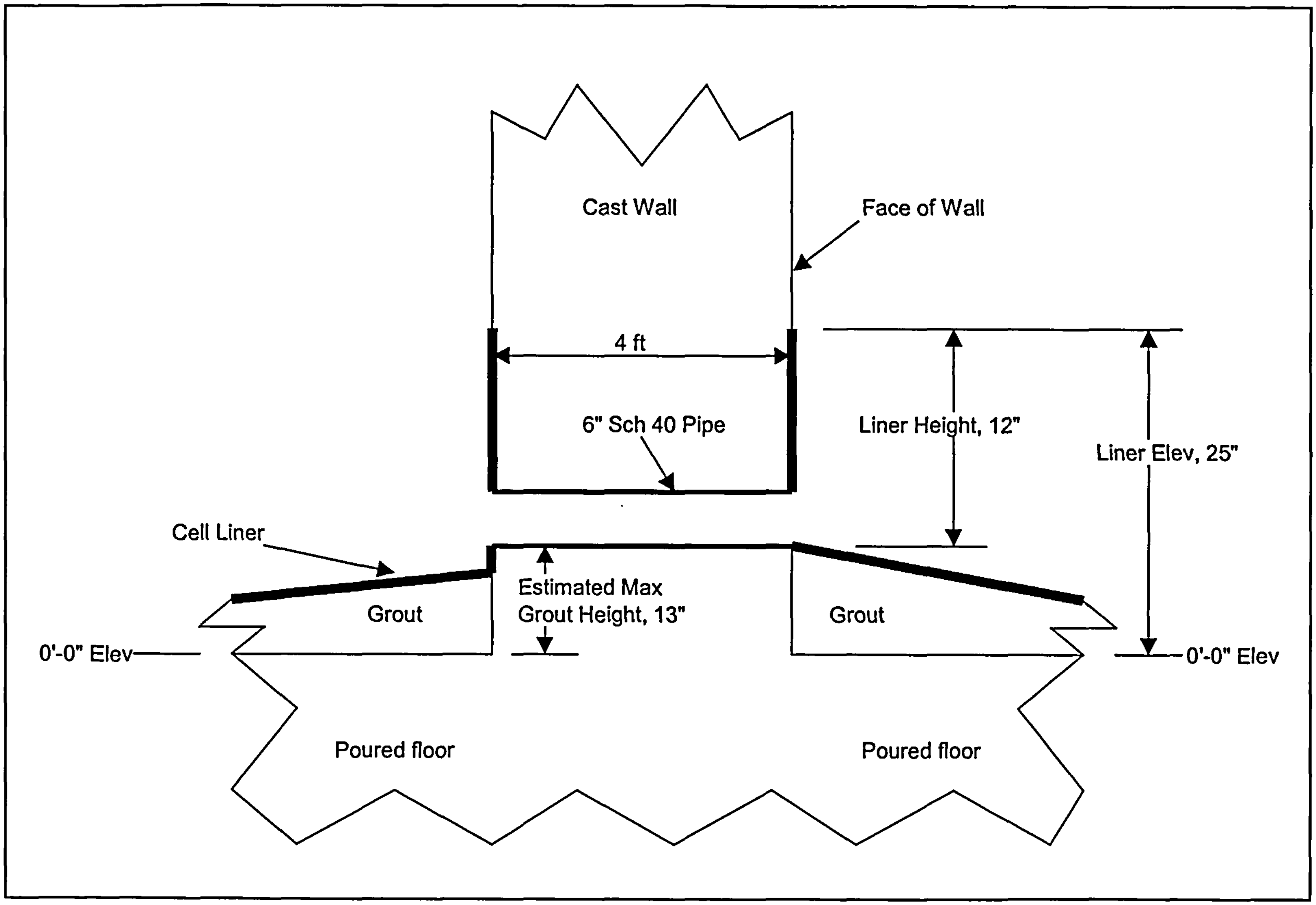


Figure C6 Flow in Hydraulic Connection

Assume: Water @ 70 degree F

kinematic viscosity water 70°F (v) =	1 06E-05 sqft/sec	
specific roughness (e) =	0 0002 ft	
Water Velocity (V) =	4 27 ft/sec	
Acceleration of gravity (g) =	32 2 ft/sec^2	
Diameter (D) =	0 505417 ft (6 inch shed 40)	
Area (A) =	0 200627 ft^2	

Determine Loss due to exit

$h_{exit} = KV^2/2g$

K =	1 (Crane, Page A-26)	
g =	32 2 ft/sec^2	
V =	4 27 ft/sec	
h_{exit} =	$\boxed{0 283}$ ft head	

Determine Loss due to entrance

$h_{ent} = KV^2/2g$

K =	0 5 (Crane, Page A-26)	
g =	32 2 ft/sec^2	
V =	4 27 ft/sec	
h_{ent} =	$\boxed{0 142}$ ft head	

Determine Loss due to Pipe length (h_{fric})

Determine Reynolds number (Re)

Re = DV/v

v =	1 06E-05 sqft/sec	
V =	4 27 ft/sec	
D =	0 505417 ft	
Re =	203,597 unitless	

Re > 2100 therefore Turbulent flow

Determine friction factor (f)

e =	0 0002 ft	above
D =	0 505417 ft	above
Re =	203,597 unitless	above

Use Swamee-Jain equation, page 17 5 eq 17 21

5 75/Re$^{0 9}$ =	9 59E-05	
e/De/3 7 =	0 000107	
f =	0 0183	

Darcy equation to find head loss due to friction

$h_{fric} = fLV^2/2Dg$ =

L =	4 ft	
g =	32.2 lbm-ft/lbf-sec^2	above
f =	0 018332	above
V =	4 27 ft/sec	above
D =	0 505417 ft	above
h_{fric} =	$\boxed{0 041}$ ft head	

Determine total loss (h_l)

$h_l = h_{exit} + h_{ent} + h_{fric}$ h_l = $\boxed{0 466}$ ft head

Determine losses at point A

From Figure h_A = 9 in head = $\boxed{0 75}$ ft head

Determine losses at point B

$h_B = h_A - h_l$ h_B = $\boxed{0 264}$ ft head

Determine the flow (Q)

$Q = CA(2gh_B)^{1/2}$

C =	1 (flow coeffecent, losses included in h)	
A =	0 200627 ft^2	above
g =	32 2 ft/sec^2	above
h_B =	0 264 ft	
Q =	0 86 ft^3/sec = $\boxed{385}$ gpm	

Check Velocity (V)

V = Q/A

Q =	0 858376 ft^3/sec
A =	0 200627 ft^2
V =	$\boxed{4 278}$ ft/sec